
Prepared for Federal Communications Commission

**Comments on Measurement of
Mobile Broadband Network
Performance and Coverage**

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Prepared by:

Ascom Network Testing Division
25541 Commercentre Drive, Suite 100
Lake Forest, CA 92630
Contact: Paul Kinderman
+1.678.523.7986
paul.kinderman@ascom.com

1.1 About Ascom

Ascom is an international provider of mission-critical communication solutions. The company focuses on the areas of Wireless Solutions (high-value, customer specific, on-site communication solutions), Network Testing (a global leader in testing and optimization solutions for mobile networks), and Security Communication (secure, reliable communication solutions for alerts, mobilization, and tactical communication).

The Ascom Network Testing division, headquartered in Reston Virginia focuses on providing test and monitoring solutions to the network operators, infrastructure vendors, governmental regulatory bodies, and professional services providers in the field of mobile networks. Its portfolio includes Testing & Measurement tools (for troubleshooting and optimizing mobile networks), Benchmarking & Monitoring tools (for maintaining quality of service during network operation), and Reporting & Analysis tools (for post-processing and optimization). Ascom Network Testing products focus on multi-technology, multi-vendor solutions that test from the end-user's perspective, so that our customers can know exactly what consumers are experiencing. This subscriber perspective is incredibly valuable for network planning, troubleshooting, optimization, and benchmarking purposes.

Ascom Holding AG is a listed company headquartered in Zurich (Switzerland), has subsidiaries in 20 countries, and employs more than 2300 people around the world. Ascom registered shares (ASCN) are listed on the SIX Swiss Exchange in Zurich (Switzerland).

1.2 Comments to FCC Questions

FCC: Measurement metrics for mobile broadband services: We seek to understand the best metrics to measure the performance of mobile broadband services. Performance of mobile broadband networks is becoming more important as mobile broadband plays an increasingly important role in our lives and in our economy.

**1. What are the best measurement metrics for mobile broadband services?
a. What performance characteristics should be tracked for mobile broadband networks (e.g., typical data throughput, signal strength, accessibility, retainability, latency, other quality of service parameters)? At what level of temporal and geographic granularity?**

Ascom: The 'best' metrics depend on the type of end user service and the audience of the metrics collected/ For example, a web radio listener will be perfectly happy with a few hundred of kbps and has fewer concerns about the latency, while the gamer needs low latency and the web surfer needs instant high throughput. In the background, the mail application really is a best effort service and gets what's left over. Then there are real-time services like streaming and voice over IP that makes the picture even more complex.

Furthermore, the type and detail of metrics to measure for mobile broadband networks depends on who is the end user of this information.

For Consumers

For consumers, the End User Experience can be measured by monitoring such more simple metrics as:

- Service Availability and Stability
- Dropped Calls
- Perceived speed of the application (ie how fast did a web page load)
- Voice Quality

There are also metrics that effect the end user experience which may be more related to device performance and are not network related. For example, how well did the webpage fit into the phone screen, quality and buffering of the video streaming. Such metrics are related in part or in whole to the device performance, but the user may still view it as an overall user experience.

For Carriers

The carriers will collect a far wider set of metrics to both understand the user experience, but also monitor the underlying metrics to proactively address potential issues and proactively resolve service issues. Some metrics the carrier may measure that both identify network performance issues as well as provide insight for trouble shooting include:

- Signal Strength (RSSI)
- Interference (Ec/Io)
- Latency (ms)
- Throughput (kbps)
- Coding Schemes
- Scanner Data and congestion
- Connect Times

All these metrics need to be tested across time and location

Time Variation: *The network performance will vary hourly, daily and seasonal. The KPIs may vary for example:*

Events: Sport events, holidays (ie SMS at New Years has significant delays)

Hourly: Rush hour vs middle of night

Daily: Weekday vs Weekend

Monthly/Seasonal: Foliage

Geography Variation: *Since the user experience is determined greatly by the user's location, Radio Access Network (RAN) measurement data must be collected from as many locations as possible, indoor and outdoor.*

- Indoor vs. outdoor
- Outdoor: pedestrian vs. vehicular
- Outdoor: rural, suburban, urban
- Indoor: residential detached, residential apartment, commercial office, public area

FCC: b. What parts of the network should be measured? What starting and ending points (e.g., radio access network, middle mile) are most useful and actionable for consumers, regulators and providers?

Ascom: For measuring the end user experience it is important to measure as close to the user as possible, this means that using test equipment that mimics the end user devices and activities will give the best correlation between the measurement and the experience. Ascom has for a very long time focused on building test tools on commercial devices that carries test software, this to measure as a user.

For carriers, RAN measurements are essential. Without this, carriers cannot evaluate network quality in a way that meaningful.

Since mobile broadband network performance is also determined by the supporting fixed networks, metrics should also be collected at network operator demarcation points, such as at GSM's GGSN Gi interface, WCDMA/LTE's PDN Gateway SGi interface, CDMA's PDSN TDM interface, WiMAX's ASN R3 interface, etc.

Inter-PLMN broadband services will become more important as video telephony becomes more popular. In this case, additional interfaces will become important test points, such as LTE's S8 interface, or the LTE-WCDMA S4-UP interface.

FCC: c. Should measurement processes and standards for mobile broadband services be different than those for fixed broadband connections?

Ascom: Currently, there are differences between fixed and mobile broadband ranging in everything from the end user devices, transmission up to servers and services used in the networks. Therefore there should also be differences in the setup of the measurements. Eventually, the two worlds will converge. As the 3GPP LTE technology will likely become a global standard replacing existing technologies such as HSPA/CDMA/WiMAX/Wi-Fi thanks to a rather simple and well defined specification together with extensive spectrum support, the need for fixed access will be limited. But still, end user performance should be comparable.

FCC: User-generated and other data gathering methods: We seek comment on methods to gather better data for mobile broadband network performance and coverage.

2. What are the best methods for collecting data on mobile broadband performance and coverage for end-users?

Ascom: The market consists of wide variety of tools including:

- *Simple Web pages or mobile applications that send traffic patterns and presents a throughput result to/from the end user*
- *Tools and probes that interfaces with the network elements.*
- *Rigorous drive test tools for wide range of metrics and detailed information.*

The tools available for collecting data on mobile broadband performance and coverage for end-users include:

- *Manual Drive Test - controlled environment*
- *Autonomous Drive Test - lack of geo control (statistics of coverage)*
- *Fixed Probes - limited in geo coverage. Good for isolating RAN and Network issues.*
- *Device-based probes - thin client (RSSI and app layer metrics)*
 - Device-based probes - embedded (full metrics)*
 - Device-based probes - embedded with control*

FCC: a. What are the best available tools in the market today for measuring mobile broadband performance and service coverage?

Ascom: The Best tools available in the market today for measuring broadband performance and services coverage are Ascom TEMS Product Family including:

TEMS Symphony: A fully integrated test platform supporting up to 16 devices and providing Device and Carrier Benchmarking for detailed technical measurements and benchmarking of services and coverage areas. The platform identifies coverage, dropped calls, throughput over a geographical area.

TEMS Investigation: A field solution based on a laptop and multiple devices to collect detail RF and network performance information. The tool is designed for RF Optimization and planning engineers.

TEMS Pocket: A test solution based on a mobile application designed to run either by the user or autonomously and collect detailed network information. The results can be uploaded to a central database, or analyzed locally on the mobile device

TEMS Monitor Master: A fixed probe solution designed to collect end to end network performance from fixed locations in the network, and identifying network issues from the end user perspective.

TEMS Automatic: A mobile probe solution that runs autonomously and installed in the trunk of taxis, buses, technician vans, etc. The probes are continuously generated voice and data traffic while collecting detailed network information, coverage and service availability. The probes are managed from a central control system."

FCC: b. Are there current data sets already available that could be useful for facilitating better consumer disclosures on mobile broadband performance and coverage?

Ascom: Yes, there are current data sets already available that could be useful for facilitating better consumer disclosures on mobile broadband performance and coverage.

These data sets include:

- A) Network operator drive test reports and maps.*
- B) Independent rating services drive testing*

C) Crowd sourcing

D) Network operator analysis from CDR databases and Network Element logs

FCC: c. Are there existing technologies that can measure actual end-user experience on mobile broadband networks? If so where could the measurements take place (e.g., on the device, inside the network)?

Ascom: Yes, there existing technologies that can measure actual end-user experience on mobile broadband networks. Preferably the measurement is taken at the device or in a PC connected to the internet via the mobile broadband modem.

Ascom portfolio includes tools for on device testing in the form of TEMS Pocket that capture the user experience on their actual actions. Ascom also provides solutions such as TEMS Investigation, TEMS Automatic and TEMS Symphony that can perform testing on real devices simulating normal user behavior.

FCC: 3. How can user generated data (i.e., ‘crowdsourcing’) on mobile broadband network performance and coverage be utilized to assist in collecting data and improving transparency?

a. What efforts and technologies currently exist that can enable device level data collection on performance and coverage of mobile broadband networks? What metrics could a device level software application collect that could measure mobile broadband performance and coverage (e.g., signal strength, data throughput rate)? What other data points would be valuable to collect in association with that data (e.g., location, tower ID, handset type)?

Ascom: At the moment Ascom views crowd sourced data as a complement to traditional data collection utilizing drive testing, this because the crowd sourced data does not give the detail level to be able to perform trouble shooting or perform radio network tuning. With proper statistical base it can be used to give a hint about the actual network performance from a user perspective on real devices. However crowd source data does not replace the need for more controlled and rigorous drive testing as currently preformed worldwide. The more information that is available from the network configuration the more value can be extracted and the collected data can be used for several purposes in the operator’s organization.

The metrics a device level software application could collect that could measure mobile broadband performance and coverage include:

- Radio technology (LTE, R99, HSPA, GSM, CDMA etc)
- Cell and Network identity (CID/NID/LAC/MCC,etc)
- End user device type
- End user operating system
- Time of day/date
- MTU size (IP packet size)
- Throughput
- Latency

The measurements collected require various levels of access into the device and furthermore have different impacts to the user. For example, an on-device client that collects significant data on the device may slow down the phone GUI and also decrease the battery life. Such impacts need to be seriously considered. The challenge with the collecting this information from the device is the lack of common standard to read this type of information from devices and chipsets.

FCC: b. For collecting device level data, what impact does the type of device (e.g., smartphone, feature phones, laptop, wireless modem) itself have on end-user experienced network performance? How, if at all, could a measurement methodology take variations resulting from device type into consideration?

Ascom: There are significant differences between Smart phones, laptops, feature phone that needs to be taken into account for the user experience of network performance. There are also fundamental differences in the device hardware performance, host operating system, radio chipset and used radio technology and even in the network infra structure that can give a difference between operators and the reported metrics. All this and time of measurement, location and user service will affect the user experience.

The user also does not necessarily know how to differentiate between the device performance and user performance. So on a Smartphone with a higher end processor and high definition display, the video stream may be perceived as better than a lesser device. While the actual video streamed from the network is identical. This perceived quality can possible be addressed by prompting the user for a on device questionnaire to gather more details of their experience.

FCC: c. How could measurement methodology account for variations in performance due to the location (e.g., basement of house vs. above ground) or movement (e.g., user on a train) of the end-user? How can we account for differences in location determination methods (e.g., GPS) across handsets and providers, if any? How should buildings, topography, weather, continued network build-outs, and other service availability variables be accounted for in the methodology?

Ascom: Crowd sourcing databases lack control of mobility factors such as speed and height. Furthermore, you must differentiate between long term average and sudden drops in performance. Advanced post processing tools and statistics are needed to group the data in many dimensions depending on usage of the collected data. Data should also be aged out to accommodate network and environmental changes. It is also important to maintain segregated data sets of drive tests vs. crowd source and compare for any location the signal from each (or other metric). Crowd source will have greater variance due to the factors noted, while drive test is more controlled and will inform the user about base level performance, while crowd source metrics will show the variations for that location speed and height

FCC: d. Can a statistically robust sampling method correct for the variables described above, such as the impact on performance and coverage measurements of movement, device and location variability?

Ascom: The data samples will all be correct inasmuch as they represent the factors involved; thus "correction" is not required. However, proper representation of the data means that a simple average is not enough. The distribution of performance is necessary to characterize a data set including the many effects noted.

FCC: e. How can we measure performance with minimal impact on the network itself? For example, how can active measurement techniques that generate additional network traffic mitigate potential increases in congestion?

Ascom – This is an interesting area and research is ongoing (e.g. the BART algorithm) as measuring during low load hours only gives in hand the maximum throughput and not the typical end user experience.

Properly planned testing (drive test and on device test) does not significantly impact the network performance, using only a fraction of the resources available. However, each test methodology can impact the network performance if not properly controlled and planned. For example, a drive test platform can easily be setup to download several large files on the same network and impact the cell site capacity and end user experience. Also crowd sourcing approaches could impact the network by excessive results backhauling loads.

FCC: 4. What are the benefits and costs of measurement for providers, regulators, customers and others?

a. What are the benefits (e.g., transparency, better data, network and international comparability, benefits for researchers, verification of National Broadband Map grantee data)?

Ascom –

Operators: The benefits include reducing customer dissatisfaction and churn, knowing how to efficiently allocate resources to optimize the network, to be able to proactively address network shortcomings, and to quantitatively assess performance vis-a-vis competitors.

Regulators can assess service quality offered to consumers, protecting consumers against misleading advertising and educate consumers about current technical capabilities. Furthermore, our experience from working with many regulators normally shows that when a regulatory body enters the area to verify the networks the quality of the networks is improved.

Customers also have a lot to gain, with improved fore-knowledge of purchases. They gain secondarily if network operators improve service.

Researchers can provide new analyses, at low cost, if data is available. Certainly, international comparisons could be made.

In the end, it is very important these tools and technologies help drive development in radio technologies that utilize the spectrum as a natural resource in the most effective way as we expect the wireless industry to become the major contributor to the internet traffic. Comparable performance figures will lead to competition between the network operators and in the end improves end user satisfaction. Competition gives better end user experience and leads to better utilization of the spectrum as our natural resource.

FCC: b. What are the costs (e.g., hardware costs, usage of the network, consumer hassle, accurate information already exists)?

Ascom: The cost vary greatly dependant on factors such as size of networks, continuous measurements or spot testing, statistical significance, number of networks to measure, services to perform testing on etc.

A general price range of test solutions:

On-Device – ‘thin’ client \$0 to \$X00

On-Device – ‘thick’ client \$2k - \$10k

Drive Test - \$10k - \$40k

Drive Test - Benchmarking \$30k - \$400k

Fixed Probe: \$10 to \$50k

Some indirect costs of on device clients may include the effect of Consumer Hassle: tests in Europe have demonstrated that consumers become less responsive to requests for testing over time and must be allowed to "rest" in order to keep a good rate of responses.

FCC: c. Are there any legal, security, privacy or data sensitivity issues with collecting device level data? If so, how can these issues be addressed?

Ascom: For crowd sourcing, privacy laws must be respected and data must be depersonalized. For example, subscriber information can removed and only the device can be identified on the serial id of the device.

In addition, consumer trust and confidence must be respected. This requires that the consumers be informed and given choice. Consumers should be given value for what they provide, other than vague assertions of network quality improvement. This could be a simple rebate on monthly bills or perhaps the access to the National Broadband Database or something else.

FCC: Publication and communication: We seek comment on the best methods for publishing and communicating mobile broadband network performance metrics to consumers to help them make informed choices about mobile broadband services.

5. How could information on mobile broadband performance and coverage be better communicated to consumers?

a. What are the current best practices for displaying or communicating mobile broadband performance and coverage to consumers today?

Ascom: Online interactive coverage maps are the most informative and personalized items available to most consumers. In Sweden the bredbandskollen.se is one first step where regulatory is performing testing with commercial users devices to give a view of the user experience of the mobile networks. Somewhat limited to only show the throughput figures and not much information about the mobile networks

FCC: b. Are consumers currently being provided with enough accurate and detailed information about performance and service coverage to make informed choices between different mobile broadband network providers?

Ascom: Today the user perceived quality is not only about the mobile network but also about the device under test, used service it is targeted at the mobile device or not. So this means that it is extremely difficult for a normal user to know if the service provider's reported metrics are good or even applicable for how they want to use their service. For example, a blackberry user who focuses on voice, SMS and email does not have much to gain in higher throughput, and instead would be interested in general coverage and availability. Whereas a teen doing a lot of video streaming wants to know the coverage area of highspeed services.

FCC: Current mobile broadband network performance and coverage disclosures: Existing voluntary disclosures related to mobile broadband performance and coverage have proven valuable for consumers. Providers of mobile broadband services usually provide coverage maps and 'up-to' or 'typical' data throughput rates. Third-parties also provide and compile coverage maps for providers (American Roamer) and consumers (Root Wireless). While existing data on mobile broadband services are helpful, gaps remain. For example, the currently provided 'up-to' or 'typical' data throughput rates are rough estimations of actual performance and some coverage maps provide a binary 'yes' or 'no' reading without accounting for signal strength at particular locations, whereas other maps provide more layered readings (such as indoor/outdoor or 'good'/'better'/'best'). Additional voluntary performance measurements and standards could provide better information enabling consumers to make informed choices about mobile broadband services.

6. What measurements are typically performed by service providers today to track mobile broadband network performance and service availability?

a. What tools are currently available for consumers to check coverage and performance at a specific geographic location by mobile broadband network (e.g., coverage maps), and how accurate are the data for typical outdoor and indoor consumer use?

Ascom: There are a lot of tools available, depending on the level of information needed. From freeware device applications to in depth analysis tools. Speedtest.net, Sensorly.com, bredbandsfakollen.se are all examples of open applications to present possible coverage but the statistical accuracy cannot be presented or guarantee.

FCC: b. How are data for coverage and service area maps collected, verified and displayed (how compiled, how accurate, how granular)? How are data on mobile broadband performance (i.e., data throughput rates) measured and displayed?

Ascom: Operators and third party companies offer online or instore maps. The geographic granularity is quite limited and not useful down to the level of individual households. Furthermore, the online operator maps to a consumer appear to be interpolated or predicted rather than measured and provided to the micro level of the user. (ie how is the coverage from inside his house).

The maps available to consumers also focus on basic metrics such as coverage and throughput. There are other metrics that have a more immediate and noticeable impact to the user such as traffic congestion, dropped calls, poor voice quality.

FCC: c. What technologies are used to collect such data (e.g., RF modeled coverage, drive tests, network reporting, handset data collections)?

FCC: d. Are there any voluntary industry standards that are being used in disclosing mobile broadband network performance and coverage to consumers? How could these be improved (e.g., signal strength or throughput bands to map different levels of service quality)?

Ascom: European operators have standards called ETSI STQ Mobile specifies a number of KPI's (key performance indicators (KPI's) designed for use in mobile broadband networks. They are implemented in drive test like tools.

The advantage of ETSI is they have very well defined KPI's within ETSI STQ Mobile and available for different types of applications. However the accurately and correctly measure per ETSI standards, requires rather complex and expensive tools for collection and post processing/reporting.